New multiple ion counting-ICPMS system for Age Cytometry

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The MC-ICPMS instruments, equipped with a multiple ion counting system setup, can improve the precision of the age determination, and the data quality achieved by the LA-ICPMS technique is comparable or enhanced compared to those obtained by secondary ion mass spectrometry (SIMS). With the conventional ion counting system, the gains of the ion detectors (electron multipliers) must be calibrated regularly through the elemental analysis for standard materials. This results in elongation of the analysis time for the age determinations. To improve the long-term stability, and also to improve the accuracy of the age data, we have developed new ion counting system using Dalty collector. In this study, two Daly collectors were adopted to the MC-ICPMS instrument (Nu Plasma II, Wrexham UK), and were used to measure 206-Pb and 207-Pb signals. With the Daly ion collectors, both the medium to long-term stability could be remarkably improved from 0.1%/hrs to 0.04%/hrs. Moreover, the counting loss due to dead time of the ion counting system can be corrected based on the conventional non-extendable law, and the beam sizes of greater than 10 MHz (cps) can be successfully measured by the Daly collector. With the multi-ion counting technique, the analysis time for U-Th-Pb age determinations can be significantly reduced down to 1 - 10 sec/spot, and the shorter analysis time enabling to obtain an age distribution of the zircons collected from a sample (age cytometry). This analytical approach allows to decipher the contribution of multiple geological events or multiple sources of the zircons. The “age distribution” is a useful approach to understand the geological sequence underlying the sample formation.

With shorter duration time for the laser ablation, the resulting depth of the ablation pit can be smaller than 1 μm, and therefore, age determinations from thin-layer rim of zircon crystal can be made. Schmitt (2011) reported that the U-Th-Pb age derived from the outer rim (<5 μm) of the zircon crystals can reflect the timing of overgrowth through eruption processes [Schmitt, 2011]. This means that multiple chronological information can be derived from a single zircon grain. With the shorter ablation time achieved by the MC-ICPMS system setup, precise U-Th-Pb ages can be derived from the depth of shallower than 1 μm. This technique can be applied for geochemical evolution processes within magma chambers by determining the difference between crystallization of the zircons and timing of eruption, and thus the U-Th-Pb ages obtained from the rim of zircon crystals can reflect low-temperature geological events. In this presentation, analytical capability of the multi-ion counting technique using Daly collector for the age determination will be demonstrated.

Reference

Schmitt A. K. (2011) Uranium Series Accessory Crystal Dating of Magmatic Processes, Annu. Rev. Earth Planet. Sci., 39, 321-349.

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